Miniaturized Atomic Fountain Optical Table

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Abstract

Using commercially available components at a comparable cost to conventional free space optics, we have built a miniaturized version of the optical set-up for the USNO Rb fountain that fits onto a 40 cm by 55 cm rack-mounted breadboard.

With 1 Watt of fiber-delivered laser input, the table delivers (again via fiber) 6 frequency-tunable collection/launching beams of 40 mW each as well as repumper and detection outputs, and an output for FM spectroscopy.

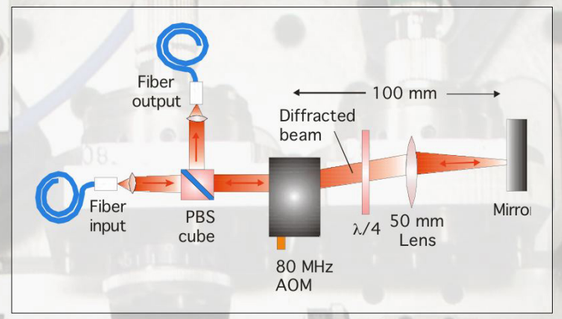
The optical bench has been in operation since late 2004, and has run without any realignment since January 2005.

Optical Layout

On the L-shaped table, two AOMs in a “cat’s eye” double-pass arrangement are used to produce 6 launching fiber outputs. On the straight table, another double pass provides a resonant probe output . The AOMs are used for both frequency shifting and intensity control. A repumping beam is generated using an EOM at 6.8 GHz.

Details

“Cat’s eye” double pass

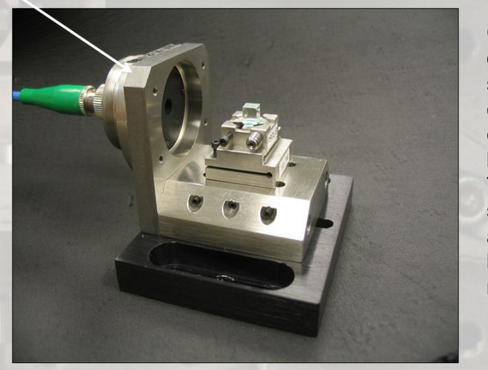


A “cat’s eye” double pass arrangement allows for frequency tuning of the AOM while maintaining good fiber coupling. The lens is placed one focal length from both the AOM and the mirror. An iris (not shown) blocks the carrier and unwanted diffracted orders from the AOM. A commercial mechanical shutter with a modified housing (see figure at left) is placed between the lens and the mirror.

Performance

We have demonstrated fiber-to-fiber coupling efficiency of up to 50% including AOM diffraction. Overall coupling efficiency is 20-30% when splitting to multiple output fibers and includes power loss due to intensity stabilization with the AOM’s. The small size also improves alignment stability. The optical bench has been in hands-free operation since January 2005.

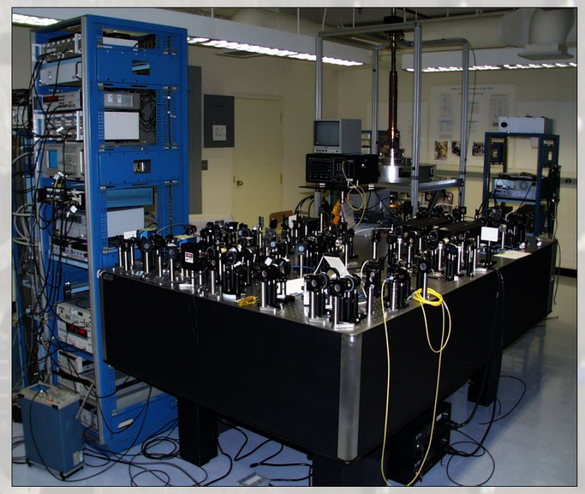
Fiber to free-space components



Commercially available optics are used for free-space beam to fiber coupling. The fiber coupler uses an aspheric lens with 5-axis alignment. The 5mm polarizing beam-splitter cube is mounted on a monolithic flexure base having three degrees of motion.

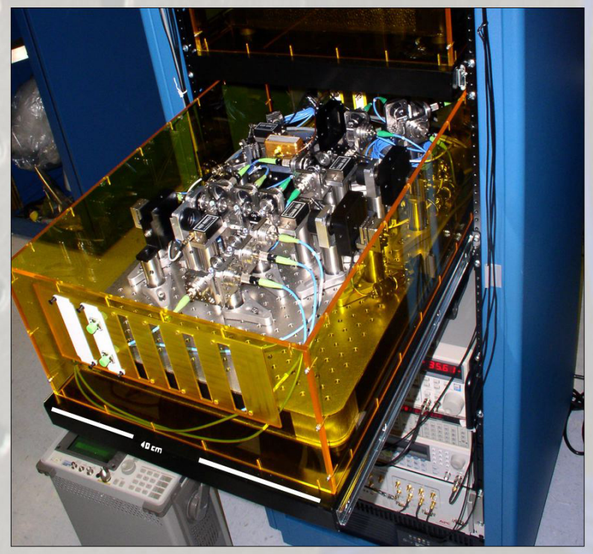
Photos

BEFORE: Cs Optical Table, 2001



USNO Cs fountain optical table takes up most of a 2.7m by 1.7m optical table as well as free space optics on the physics package. The housing of 6 Rb fountains requires a miniaturized optical setup.

AFTER: Rb Optical Table, Sept 2004



Rack-mounted miniature Rb optical table inside a plexiglass enclosure. The small breadboard sits on vibration isolation mounts and slides out of the rack on a drawer for access.